The Fuzzy Boundaries between Post-disaster Phases After the Earthquake in L'Aquila - Italy

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Key words: Post-disaster phases, indicators, monitoring, assessment, earthquakes.

SUMMARY

A number of indices have been developed for measuring vulnerability to natural phenomena, but little attention has been paid to recovery indices particularly with respect to earthquakes. Post-disaster periods are usually divided into four phases based on specific time. The name established by the UNDP ("relief", "early recovery", "recovery" and "development") have been used in this working paper. This research examines the hypothesis that the time between post-disaster recovery phases is fuzzy and should be defined by the progress achieved in the recovery process, rather than by the amount of time elapsed since the event. The methodology employed involved four steps: (1) fieldwork, (2) mapping, (3) the selection of indicators, and (4) assessment. The case study area was L'Aquila in Italy, which was struck by an earthquake in 2009. Each phase of the recovery process at L'Aquila was assigned a score according to the progress observed at April 2014, with the highest score going to the early recovery phase (6 points), followed by the recovery (4 points), the development (2 points), and the relief phase (1 point). The results have demonstrated the possibility of determining post-disaster recovery phases in an affected area according to its achievements measured through indicators rather than in terms of time.

SUMMARY

Una serie de índices han sido desarrollados para evaluar la vulnerabilidad a los fenómenos naturales, pero poco se ha investigado con respecto a los índices de recuperación, particularmente con respecto a los terremotos. Los periodos post-desastre usualmente se dividen en cuatro fases basadas en periodos específicos de tiempo. Las denominaciones asignadas por el PNUD ("socorro", "recuperación temprana", "recuperación" y "desarrollo") han sido usadas en el presente artículo. Esta investigación demuestra la hipótesis que afirma que los límites entre las fases post-desastre son difusos y que cada fase debe ser definida de a acuerdo con los avances logrados, y no de acuerdo a periodos específicos de tiempo. La metodología empleada incluye cuatro pasos: (1) Trabajo de campo, (2) cartografía, (3) selección de indicadores, y (4) evaluación. El área caso de estudio es L'Aquila en Italia, sacudida por un terremoto en el año 2009. Cada fase del proceso de recuperación en L'Aquila, obtuvo una puntuación de acuerdo con los progresos observados a abril de 2014, obteniendo el más alto puntaje la fase de recuperación temprana (6 puntos), seguido de la fase de recuperación (4 puntos), la fase de desarrollo (2 puntos), y la fase de socorro (1 punto). Los resultados han demostrado la posibilidad de establecer las fases de recuperación post-desastre alcanzadas en el área afectada según logros en el proceso de recuperación medidos en términos de indicadores y no en términos de tiempo.

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1. INTRODUCTION

On April 6th of 2009 an earthquake with a magnitude of 6.3 MW and a hypocentral depth of 10 km struck the Italian city of L'Aquila (population 72,800). The epicenter was located in Poggio del Roio, 3.4 km to the southwest of the L'Aquila city center.

L'Aquila is the capital of the province by the same name, and the administrative capital of the Abruzzo region. Its location is shown in Figure 1, together with a map showing ground motion intensity during the earthquake.

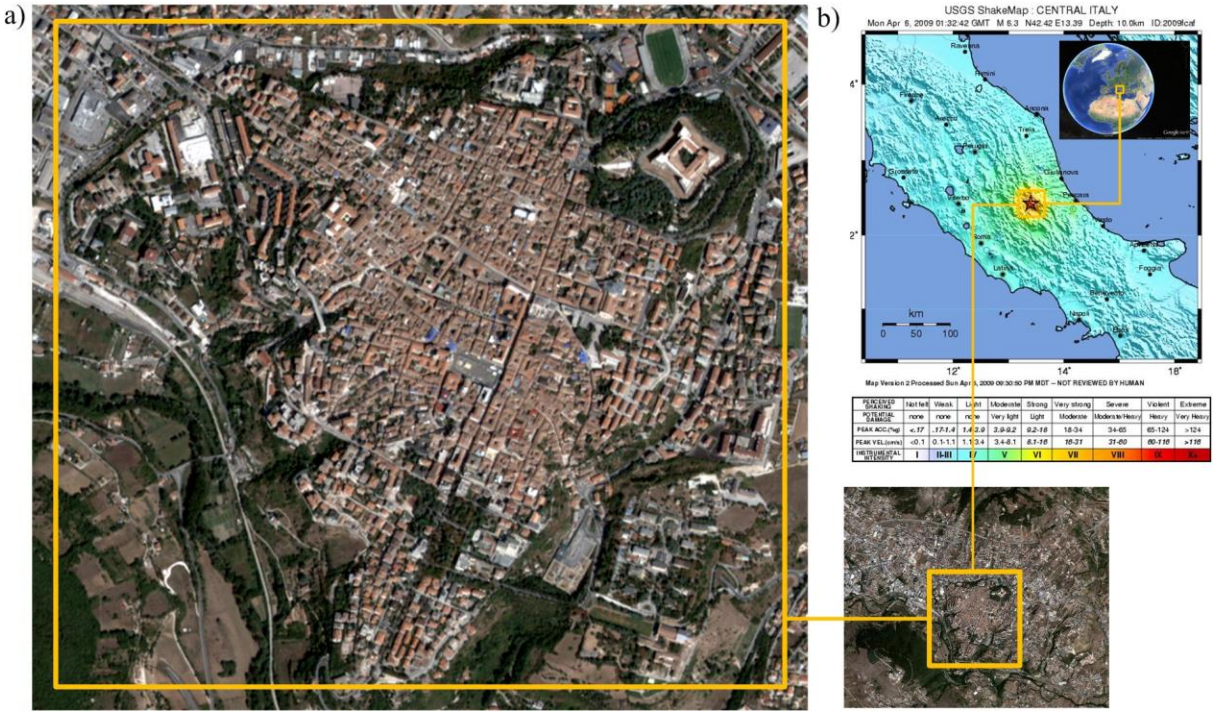

Figure 1. Case study area: L'Aquila (Italy).
a) Location. (Source: Google Earth – *QuickBird*/*DigitalGlobe*, distributed by European Space Imaging on 11 September 2011.); b) Map of ground motion intensity during the L'Aquila earthquake (Source: USGS).

The historical city was badly damaged, 67,500 people were left homeless(Alexander, 2010b), 1,500 people were injured (202 seriously), and 308 people lost their lives 10,000 buildings were damaged

and between 1.5 and 3 million tons of waste were generated (C. Brown, Milke, & Seville, 2011) (between 4 and 5 million tons according to (Díez, 2010). The cost of the damage was estimated to be 16 billion Euros (UNIFI, 2009).

Reconstruction programs such as the Complessi Antisismici Sostenibili ed Ecocompatibili (C.A.S.E) "aseismic environmentally friendly units" project, and the Moduli Abitaviti Provvisori (M.A.P) "temporary housing unit" program, resulted in the construction of 5,722 housing units for the homeless population in 19 new settlements distributed around the city at various locations (Contreras, Blaschke, Kienberger, & Zeil, 2013). The C.A.S.E and M.A.P. projects resettled 11,923 and 2,482 displaced residents from L'Aquila, respectively. Six months after the earthquake only 25% of the displaced inhabitants were able to return to their former homes (Gigantesco et al., 2013). One year after the earthquake 5,000 of the survivors that used to live in the city center were still housed in hotels, 15,000 in provisional housing, and 27,000 in rented accommodation with a government grant of between €600 and €800 per month (Díez, 2010).

This expensive housing resettlement solution resulted in a number of problems including a lack of basic services, lack of urban facilities (e.g. churches, schools, pharmacies, post offices, supermarkets, social centres, sport centres etc.), lack of spatial connectivity (Contreras, 2015; Contreras et al., 2013), social fragmentation (Ambrosetti & Petrillo, 2016; Forino, 2014; Geipel, 1979) and functional living, and questionable ecological values (Alexander, 2010a).

2. LITERATURE REVIEW

For the purpose of this paper, recovery is defined as a complex multidimensional long-term process involving planning, financing, decision making, and reconstruction, aimed at restoring sustainable living conditions to a community or an area that has been strongly affected in the physical, social, economic, institutional, cultural, and ecological dimensions as a result of vulnerability that existed prior to an event (Contreras, Blaschke, Kienberger, & Zeil, 2011). In such a situation the recovery process must not only involve the reconstruction of buildings and restoration of infrastructure, but also address the interactions between diverse groups and institutions with the aim of rebuilding people's lives and livelihoods as well as restoring cultural assets and ecological conditions (Contreras, Blaschke, Kienberger, & Zeil, 2014).

Although this uncertain and often conflict-laden process is nonlinear and has no clear boundaries, it is usually divided into four phases. A summary of the denominations for each recovery phase according to different authors is presented on Figure 2. For this research the names established by the United Nations Development Programme (UNDP) have been adopted, these being the "relief", "early recovery", "recovery" and "development" phases (UNDP, 2008a).

More vulnerable zones have longer recovery phases (Wisner, 2004). Each post-disaster phase is characterized by unique functional and operational requirements (Kates & Pijawka, 1977). Furthermore the recovery phase is determined by the unique history of the area (Karatani & Hayashi, 2007). The assessment of recovery processes following an earthquake needs to be based

on specific indicators in order to ensure objectivity and comparability (Shohei, 2007). Aldrich (2012) considered six main factors and resources that determine recovery rates, these being the provision of aid to survivors, the level of damage, the population density, human factors (such as education job skills, employment experience, etc.), social factors, and capital (savings) available (Aldrich, 2012). However Dacy and Kunreuther (1969) considered that recovery progress was mainly dependent on the damage in the physical dimension.

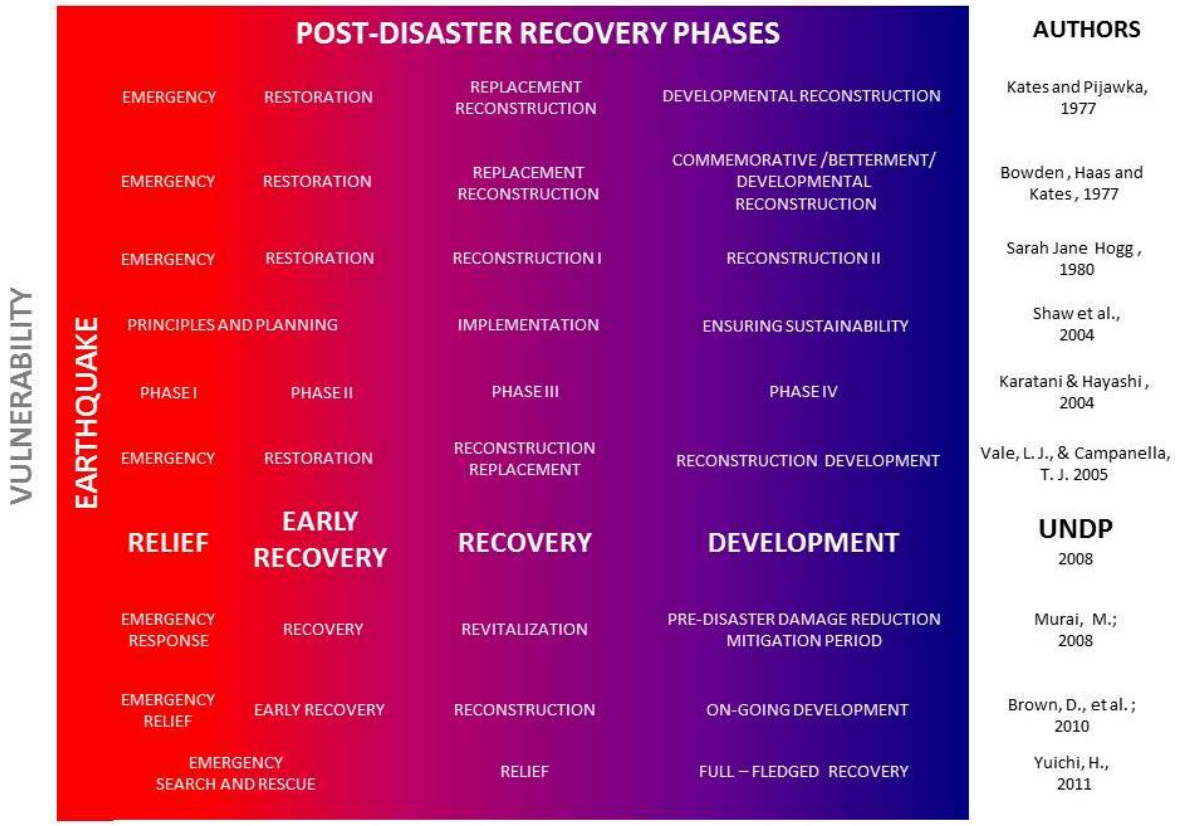

Figure 2. Names assigned to post-disaster recovery phases by different authors.

Kates and Pijawka (1977) divided recovery processes into four time periods: an emergency period lasting between a few days and about four weeks; a restoration period lasting from two to nine months, a replacement-reconstruction period lasting from 3 to 20 years, and finally, a phase of developmental reconstruction for which the authors did not specify a period of time. Another temporal model consisting of four post-disaster periods was proposed by Bowden et al. (1978), in which each of the first three periods lasts approximately ten times as long as the previous period. Karatani & Hayashi (2004) also considered four phases (for the Kobe earthquake), but included an additional pre-disaster phase designated "Phase 0" that started two years before the earthquake. According to these authors, the relief phase take nine months, the early recovery phase take three years, and the recovery phase take 4 years. Other authors such as Brown et al.(2010) defined some particular activities that should start, continue, or be completed in each phase, without suggesting a particular amount of time for each phase.

3. HYPOTHESIS

Post-disaster periods are usually divided into four phases based on specific time. This research examines the hypothesis that the boundaries in the time between post-disaster recovery phases are fuzzy and there are always overlaps between all the recovery phases. It is proposed herein that the post-disaster recovery phase attained in an affected area should be defined by the progress achieved in the recovery process, as measured by specific indicators, rather than being simply determined by the amount of time elapsed since the event.

4. METHODOLOGY

The methodology for this research involved four steps: (1) fieldwork, (2) mapping (3) the selection of indicators, and (4) assessment.

4.1 Fieldwork

Three field visits were made to L'Aquila, one, three, and five years after the earthquake in 2009 (i.e. in 2010, 2012, and 2014). The main activities during the field visits involved (1) visits to and around the former red zone (to which access was restricted following the earthquake), (2) visits to the new settlements around L'Aquila (3) collecting cadastral data and aerial photographs of L'Aquila, and (4) interviewing members of the Department of Civil Protection in 2010, and members of the *Settore Ricostruzione Pubblica - ufficio Progettazione* (Office of Public Reconstruction – Office of Design) in 2014.

A monitoring schedule, including details of the tools used to collect the data, was defined as an essential part of this research. This schedule was formulated from the start of the program, but subsequently adjusted according to the availability of the means, resources, and data required for the research (Contreras, Blaschke, Tiede, & Jilge, 2016). This monitoring program is detailed in Table 1.

TIMELINE		REMOTE SENSING (RS)			GROUND OBSERVATIONS (GO)		GEOGRAPHIC INFORMATION SYSTEM (GIS)	
N*	**YEAR**	**MONTH**	**SENSOR**	**Analysis**	**MONTH**	**TOOLS**	**MONTH**	**SOFTWARE/APPLICATIONS**
0	2006	September	Quickbird	OBIA GIS				
	2009	April	Quickbird	OBIA GIS				
1	2010				April	GPS Analogue maps interviews	July to December	Arc GIS 9.3-10 Google Earth Google Maps
	2011	September	Quickbird	OBIA GIS				
3	2012				September	GPS Analogue maps	September to December	Arc GIS 10.1 Google Earth Google Maps
	2013						January to July	
5	2014 2015				April	GPS Analogue maps interviews	April to February	Arc GIS Google Earth Google Maps
10	2019**	April	Quickbird	OBIA GIS	April	GPS Analogue maps interviews		

Table 1. Monitoring schedule of the post-disaster recovery progress in L'Aquila (Italy).
*Number of years after the earthquake
** Fieldwork planned.

4.2. Mapping

This activity entails six steps: (1) fieldwork, (2) selection of a sampling area: the city center of L'Aquila; (3) selection of the variables and indicators in the physical and socioeconomic dimension; (4) analyzing the progress of recovery using spatial indicators by comparing the changes in the building use before (2009) and after the earthquake in 2010, 2012 and 2014, as well as building use for the same years; (5) combination of results with weights allocated by experts to the key spatial variables, and indicators in a recovery index; 6) determine the hotspots of recovery in L'Aquila. The building use before the earthquake is based on the observation of the announcements and the photographs taken during the fieldwork, Google maps, as well as information extracted from photographs available in available in the 3D model of the city of L'Aquila in Google Earth. The changes in restrictions and building use in L'Aquila between 2009 and 2010, 2012 or 2014 are depicted in Figure 3.

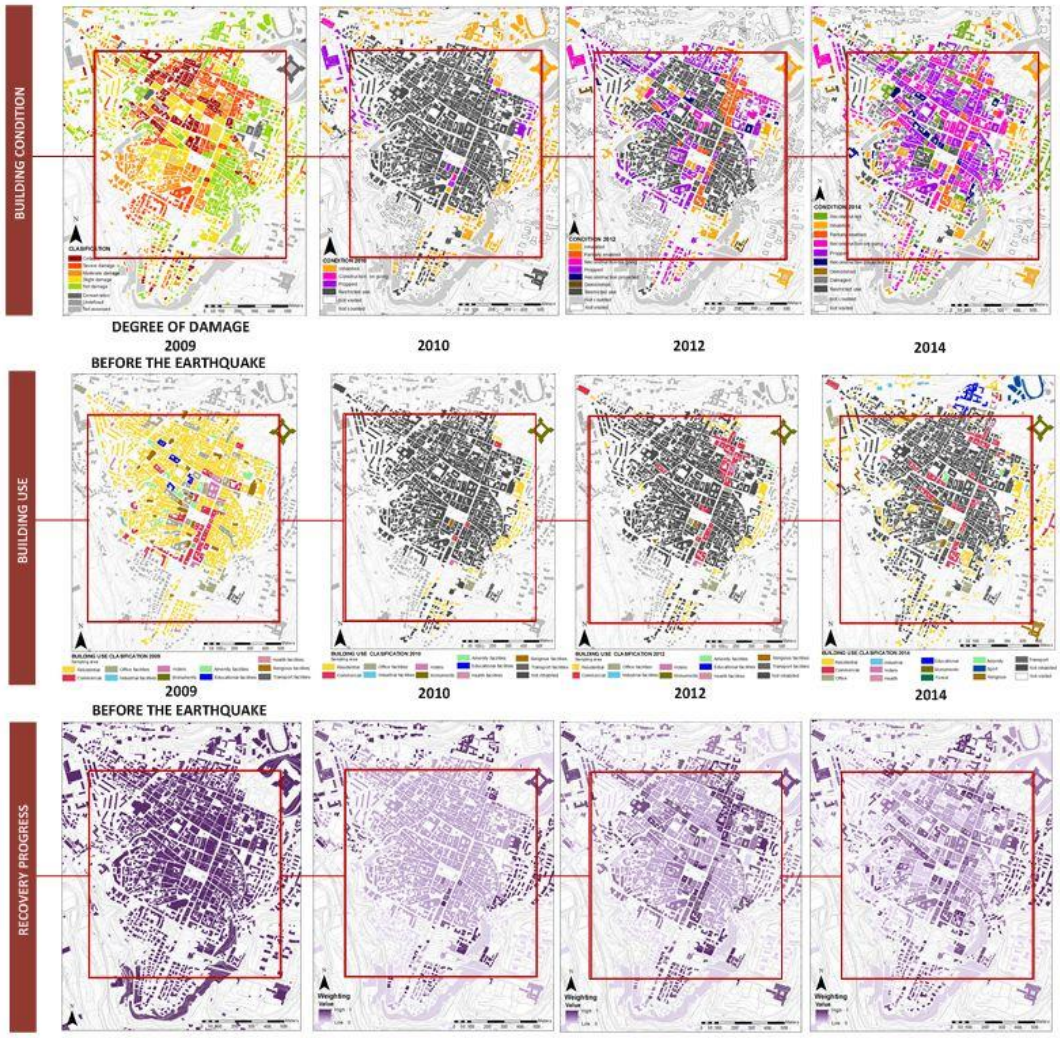

Figure 3. Changes in building condition and building use, and hot spots of recovery progress in L'Aquila in 2009, 2010, 2012 and 2014. Adapted from: Contreras et al., 2014 and Contreras et al., 2015.

4.3. Selection of indicators

The recovery indicators were selected based on the literature review on the topic of recovery indicators after earthquakes and on the basis of experience gained through fieldwork and mapping. The selection of indicators were based on the indicators taken into account by other authors to measure the progress of the recovery after an earthquake in Venzone (Hogg, 1980) Kobe (Chang, 2009; Honjo, 2011; Karatani & Hayashi, 2007), the 2004 Indian Ocean tsunami and 2005 Pakistan earthquake (D. Brown et al., 2010). These were then classified into physical, social, economic, institutional, cultural, or ecological dimension. A summarized version of the indicators and variables selected is shown in Table 2. Each dimension contains several indicators or variables that can be measured in different units during different phases of the post-disaster recovery. The post-disaster recovery phases are specified on the top of the table. The color in Table 2 indicates the post-disaster recovery phases in which some variables and indicators in specific dimensions should be measured.

DIMENSION	POST-DISASTER PHASES	RELIEF	EARLY RECOVERY	RECOVERY	DEVELOPMENT
PHYSICAL	Phenomenon				
	Lifelines				
	Building condition				
	Infrastructure				
SOCIAL	Health				
	Welfare				
	Education				
ECONOMICAL	Building use				
INSTITUTIONAL	Humanitarian aid				
	Participation				
	Public buildings				
	Studies				
	Preparedness				
	Laws				
	Land rights				
	Insurance				
CULTURAL	Monuments Conservation buildings				
ECOLOGICAL	Open spaces and parks				

Table 2. Indicators of post-disaster recovery (Summarized version).

4.4. Assessment

In order to determine which recovery phase a particular zone has reached it is desirable (but not essential) to have quantitative data (with units specified) for each indicator and/or variable. This enables specific indicators of recovery to be monitored through time.
The proposed method uses the framework presented on table 2 to estimate which post-disaster phase an area is in, but rather than using the particular quantities measured for each indicator, it makes use of a binary system to indicate whether or not the activity represented by a particular indicator is on-going in the established post-disaster phase, according to the literature review. The colors in Table 3 indicate the phase which each indicator belongs to. A number one (1) is allocated to the time slot of the phase in which the activity should have taken place. The number zero (0) is allocated when the activity did not occur in the analyzed area. Finally, the total score in each phase is compared in order to establish which post-disaster phase each area has achieved. This assessment method was applied to L'Aquila. Nevertheless, instead of considering all of the indicators listed in Table 2, only those for which primary or secondary data was available were used. The post-disaster phases with the highest score showed the phase attained at L'Aquila five years after the earthquake.

5. RESULTS

The literature review identified 146 indicators of recovery following earthquakes, of which 42 (29%) were classified as physical indicators, 42 (29%) as social indicators, 30 (21%) as economic indicators, 21 (14%) as institutional indicators, 5 (3%) as cultural indicators, and 6 (4%) as ecological indicators (Contreras, 2015). The summarized version of the indicators selected to define the post disaster recovery phase achieved by L'Aquila in 2014 (five years after the earthquake) are listed in Table 3.

DIMENSION	POST-DISASTER PHASES	RELIEF	EARLY RECOVERY	RECOVERY	DEVELOPMENT
PHYSICAL	Phenomenon	0			
	Lifelines	0	1		
	Building condition	1	1	1	1
	Infrastructure	0	1	1	0
SOCIAL	Health	0	1		
	Education		1	0	0
ECONOMICAL	Building use		1	0	1
INSTITUTIONAL	Humanitarian aid	0			
	Participation	0	0	0	0
	Public buildings		0	0	0
	Studies				0
	Preparedness				0
	Laws				0
	Land rights				0
	Insurance				0
CULTURAL	Monuments Conservation buildings			1	0
ECOLOGICAL	Open spaces and parks			1	0
	TOTAL	1	6	4	2

Table 3. Assessment of post-disaster recovery phase achieved in L'Aquila (Italy) (Summarized version).

The highest score (6 points) was obtained for the early recovery phase, followed by the recovery phase (4 points), the development phase (2 points) and the relief phase (1 point).

6. DISCUSSION

The binary system was used to evaluate the recovery phase achieved for L'Aquila, but it can be used to evaluate the progress of the recovery process of any area affected by an earthquake, based on the evaluation of each indicator per dimension. The scores in the case of L'Aquila were allocated based on the monitoring of the process between 2009 and 2014, the validation of the use of the binary system could be applied for other recovery process such as Concepción (Chile), Port Au Prince (Haiti), Fukushima (Japan), Christchurch (New Zealand) or Katmandu (Nepal). The scores obtained for each phase gave a realistic portrayal of the recovery stage attained at L'Aquila, because the recovery process in the city included a mixture of characteristics from each of the different post-disaster phases, but mainly from the early recovery phase (CWGER, 2008; UNDP, 2008b), which demonstrate the fuzzy boundaries between these phases. Electricity and gas supplies, as well as telephone lines, were reported to have been damaged by the L'Aquila earthquake (Donadio & Povoledo, 2009). Esposito et al. (2012) reported that testing and repair of more than 70% of the gas network in L'Aquila was completed within three months of the earthquake, but work on these facilities was observed by the author to be still in progress during the first field visit to the area in 2010. With regard to the road network, one year after the earthquake (in 2010) there was no access available to the cordoned-off area in the city center. Some of the roads were open by the 2012 field visit, but access still guarded by the army and police. Five years after the earthquake (in 2014) it

was possible to walk around the whole city center, in spite that some secondary streets are not still accessible for cars. Debris could still be observed the city center of L'Aquila even five, years after the earthquake. The bus terminal was damaged by the earthquake but only one year later the repair work had been completed. Some bus stops were still not in use in 2010, but by 2014 most of these were again in use.

In 2014 it was still possible to find buildings in L'Aquila that were in the same, or even worse, condition as immediately after the earthquake in 2009 (Figures 4a and 4b). Other buildings had been demolished, repaired, or reconstructed, or were undergoing reconstruction (Figures 4c and 4d) while some, such as the government palace in L'Aquila, had been relocated and reconstructed elsewhere (Figures 4e and 4f). Nevertheless, it was still possible to find houses in the city center that were in the same state as in 2010 (Figure 4g). However, the new housing erected in new settlement areas to accommodate people left homeless by the earthquake included features such as seismic isolation and solar cells, characteristics that are more closely associated with the development phase of a recovery process (Figure 4h) than with the early recovery phase indicated by the above assessment, which explains why the development phase received the third highest score of 6 points.

Parts of the main hospital were evacuated after the earthquake due to the risk of collapse (Donadio & Povoledo, 2009), but it is working normally in 2014. The emigration rate has soared and the employment security has fallen since the earthquake (Ambrosetti & Petrillo, 2016; Venturini & Verlinghieri, 2014). Alexander (2012) stated that the damage to infrastructure and the reduction in services available had resulted a loss of productive employment in L'Aquila. There is a strong correlation between the desire to move elsewhere among people who had relocated to new settlements due to the distance and the travel time to inner L'Aquila, as it was demonstrated by Contreras et al. (2013).

Figure 4. a) Buildings along via XX Settembre in 2010 (one year after the earthquake); b) buildings along via XX Settembre in 2014 (five years after the earthquake); c) building on viale Crispi in 2010; c) building on viale Crispi in 2014; e) government palace in 2009 (Photo: David Alexander); f) government palace relocated (2014) (Photos: Diana Contreras).

As pointed out by Kates and Pijawka (1977), the financial institutions tend to rebuild first and in the central business districts of cities, due to their good access to capital; examples in L'Aquila include the offices of the Savings Bank of Chieti – Carichieti – Agency of L'Aquila (Cassa Di Risparmio Della Provincia Di Chieti - Carichieti - Agenzia Di L'Aquila – Italian) (Figure 5a), the National

bank of business (Banca Nazionale del Lavoro) (Figure 5b), the Bank of Italy (Banca D'Italia), and the National Institute of the insurance (Istituto Nazionale delle Assicurazioni) (Figure 5c), which had already reopened three years after the earthquake and are located in the city center, along the main road (Corso Federico II) or close to the main square (the Piazza del Duomo).
Many tourists were observed visiting the city center in 2012 (Contreras et al., 2014) and 2014, as confirmed by officials from the Office of Public Reconstruction in the community of L'Aquila. In the years following the earthquake it has always been possible to find hotel accommodation in L'Aquila (Figure 5d), whereas the reconstruction of hotels in San Francisco following the 1989 Loma Prieta earthquake only began two years after the event (Al-Nammari & Lindell, 2009).

Figure 5. a) Savings Bank of Chieti – Carichieti – Agency of L'Aquila in 2012, three years after the earthquake (Cassa Di Risparmio Della Provincia Di Chieti - Carichieti - Agenzia Di L'Aquila); b) National bank of business in 2012 (Banca Nazionale del Lavoro); c) National Institute of the insurance in 2012 (Istituto Nazionale delle Assicurazioni), and d) Hotel Duca Degli Abruzzi in 2012 (Photos: Diana Contreras).

The government palace in L'Aquila was relocated and reconstructed, as shown previously in Figures 4e and 4f. With regard to monuments, the Castello (or Forte Spagnolo) was again open to the public from 2010, which encouraged the recovery of the city. Other monuments include churches, statues, as well as "profane"monuments. Some of these churches, such as the Basilica di San Bernardino, have remained closed during the five years to 2014 while others such as the Francesco Di Paola church still required structural support but were open to the parishioners. Some churches, such as Santa María del Suffragio in the main square, just continued with reconstruction work while at the same time remaining open for religious services; others have been completely repaired by 2014,

such as the Cattedrale Metropolitana dei Santi Massimo e Giorgio and the Basilica Santa Maria di Collemaggio.

A model of disaster recovery activities following an earthquake was formulated by Bowden, Haas and Kates (1977), based on experience gained from the recovery processes in cities such as Rapid City (USA), San Francisco (USA), Anchorage (USA), and Managua (Nicaragua). However, when Hogg (1980) tested the model with the recovery process at Venzone in Friuly, Italy, the first phase took twice as long as the Kates and Pijawka model suggested and the second phase also lasted longer, while the third phase had not been started three years later. The author eventually concluded that the differences in the time scales were due to the different size and needs of Venzone following the earthquake, compared those of the cities on which the model was based. This fact demonstrates the fuzzy boundaries of the recovery phases in the time. The results for L'Aquila presented in this paper suggest that it is not possible to test the recovery following the L'Aquila earthquake against the Bowden model because it is too difficult to ascertain how long each phase will last, which proves the hypothesis proposed by the author. Additionally, each recovery case is unique and L'Aquila is not the exception. It is therefore proposed that, instead of using discrete periods of time the post-disaster recovery should be measured in terms of overlapping time periods. Whether each recovery phase starts earlier or later, it will depend on the level of damage caused by the earthquake and the vulnerability of the affected area prior to the event.

7. CONCLUSION

Most of the indicators identified for the post-disaster recovery were physical and social indicators, followed by smaller numbers of economic, institutional, cultural and ecological indicators. Further research is required to identify additional institutional and cultural indicators for post-disaster recovery following earthquakes. There are not so many ecological recovery indicators to evaluate following an earthquake, these being more important after other kinds of natural phenomena such as floods, droughts, and landslides, or anthropogenic events such as fires, leakages, explosions, or chemical spills.

The L'Aquila earthquake occurred in 2009 and although by 2014 major advances had been made with respect to providing housing for homeless people (with seismic isolation and solar cells), locating bus stops in the new settlements, creating tax-free areas, and accelerated reconstruction activities in the city center, L'Aquila was still considered to be in the early recovery phase (D. Brown et al., 2010; CWGER, 2008; UNDP, 2008a, 2008b), the recovery phase (Murai, 2008), phase II (Karatani & Hayashi, 2004), stage II - implementation (Shaw, 2004), and the restoration phase (Alexander, 2006; Bowden et al., 1978; Hogg, 1980; Kates & Pijawka, 1977; Vale & Campanella, 2005) because of delays in the removal of debris, the continuing presence of damaged buildings, the lack of satisfaction with the recovery process expressed by the relocated community, and the high unemployment and migration rates.

The relocation of most of the people left homeless by the earthquake is not proof of recovery. The communities in the new settlements, which are located far from the center of L'Aquila, have

expressed dissatisfaction with the state of affairs and a desire to move to another location because of the distance and travel time to the center of L'Aquila (Contreras et al., 2013), the lack of employment possibilities, and the general lack of facilities (Contreras, 2015). This situation is encouraging migration away from the area (Ambrosetti & Petrillo, 2016) because a large proportion of the economic activities in L'Aquila take place in the central business district, which has been referred to by Arens (2014) as the biggest construction site in Europe. There were only a few banks, hotels and restaurants open in 2014. Some of the restaurants that had opened previously in the city center (by 2012) were closed by 2014, possibly due to the reconstruction activities, which make difficult and unsafe the access for pedestrians.

The fact that several churches, which constitute monuments within this historical city, were still undergoing repair and reconstruction five years after the earthquake indicates that the problems associated with the disaster had clearly not yet been overcome. However, the relocation and reconstruction of the government palace, the use of seismic isolation in the new settlements, and the inclusion of solar cells on their roofs and balconies' handrail (which are more characteristic of the development phase) while buildings were still being demolished, new buildings erected, and debris cleared within the city, supports the author's hypothesis that recovery phases should be defined in terms of the achievements associated with a particular phase, rather than by the amount of time that has elapsed since the event.

The results based on observations made and data collected during field visits in 2010, 2012 and 2014 (i.e. one, three and five years after the earthquake) have led to the conclusion that, rather than determining recovery phases according to periods of time they should be characterized according to the activities involved and selected variables or indicators. Every recovery case is different due to differences in the financial resources available, the political context, the degree of resilience, and the vulnerability level that existed prior to the event. The vulnerability level in L'Aquila was very high (Alexander, 2010b, 2012), which possibly explains the slowness of its recovery process.

It has been demonstrated that post-disaster phases following an earthquake have fuzzy boundaries, and that recovery phases are better defined by the objectives achieved within the affected area than by limiting each phase to a specific period of time. It is, however, recommended that assessments should be made at specific times during the post-disaster period (e.g., five and ten years after the event) as it was done in Kobe (Honjo, 2011), based on selected indicators, in order to determine the stage of the recovery process achieved. The proposed assessment method provides a means of defining the factors affecting the recovery process and will assist in formulating policies with which to solve the associated problems.

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BIOGRAPHICAL NOTES

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